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By- White, Burton L.

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The purpose of this study was to see if a change in environment affected the rate of sensorimotor development in infants. First a control group of institutionally-reared infants aged 1 to 6 months was observed to determine average age of visually directed reaching, visual exploration, visual accommodation, and the blink response. Then the environment for three experimental groups was modified in three ways. The first group was handled for an extra period of time, the second group was given an enriched visual surround in addition to being placed on their backs and handled for extra time, and the third group had pacifiers mounted on their cribs in addition to receiving the same attention as the second group. The results showed that the rate of development of visual attentiveness, hand regard, and visually directed reaching was affected by the environmental modifications practiced on the second and third groups. Research on plasticity in other areas of sensorimotor development should be carried out. Enrichment programs and education are a continuous process and should be treated as such. Furthermore, inductive theorizing should be used in the study of child behavior. (JS)

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INFORMAL EDUCATION DURING THE FIRST MONTHS OF LIFE

Burton L. White

Harvard University

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Oral Presentation to the Social Science Research Council Conference on Pre-School Education, February 8, 1966, Chicago, Illinois

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Burton L. White
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I think we would all agree that the primary goal of an educational system is to maximize the ability of each student to cope with life's various problems. Up until the last several decades, the vast majority of educators have focused their formal efforts on students aged about six to sixteen years. My feeling is that one major reason for the selection of these particular years is the prevalence of implicit adultomorphism in educational philosophy. We tend to think of the task of educating children as one where we teach them to think as we do. And how do adults think? Well, most everyone knows we use language to form our ideas to ourselves and to transmit them to others. We use formal systems of mathematics to quantify objects and events. We use other formal systems such as logic to relate events to each other and to solve problems, etc. Likewise, everyone knows that children do not respond very well to efforts to teach them language, math, logic, etc., until they get to be at least six or seven years old. Recently, of course, there have been exceptions, such as Bruner and Moore, who show us that by being very clever in curriculum construction, we can start earlier and move faster in these matters (at least with very clever children), but the general procedure of focusing specifically on inculcating adult cognitive skills remains.

But what of the years between birth and age six? As recently as 1900, except for a few men such as Pestalozzi and Froebel, very few educators had much to say. Then came the influence of Freud. By 1930, child development had come into its own as a field of study and the first five years of life, at least with respect to personality development, were accorded enormous importance. But the primary effect this seemed to have on educators was to awaken their interest in learning theory and the nature-nurture controversy. From the former grew the tendency to construct educational psychology courses around various theories of conditioning such as Pavlov's and Hull's (much to the dismay of future students of such courses). From the latter came a decade of studies which seemed to show that the rate of acquisition of motor skills was strictly limited by maturation.

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In the mid-thirties, a remarkable book was published. It was called The Origins of Intelligence in Children, by Jean Piaget. In my opinion, this was a revolutionary book. Unfortunately, partly due to the turgid quality of the writing, the influence of that book is only coming into its own now. In it, Piaget described his view of the ontogenesis of intelligence from its roots in the crude reflex-like behaviors present at birth through the day-by-day sensorimotor explorations of infancy and on to representational or ideational processes. The power of this book derives from its basis in years of observations and thousands of small but ingenious tests. It is a tribute to Piaget's genius that with an n of 3 (his own children), his findings are remarkably reproducible. Another point I'd like to make is that his book is about normal development. How many comparable studies of normal development can you think of? The nearest facsimile in child development is Lois Murphy's study of Colin reported in Personality in Young Children.

In 1961, Hunt published a book called Experience and Intelligence. In it, among other things, he made explicit the many implications of Piaget's sensorimotor theory for educators. The fundamental cognitive elements such as the sense of time, causality, space, and object which underlie intelligent activity may or may not evolve as claimed by Piaget. Nor is it necessarily true that the curiosity motive and the capacity for intelligent action may be seriously stunted or maximized as a result of events during the first and second years of life. But can educators afford not to be interested in these possibilities? I don't think so.

Piaget's studies of sensorimotor intelligence therefore involve both issues I place before you. His work plus other studies such as those dealing with the acquisition of language show beyond doubt that if we pay little attention to the events that happen in the first years of life, much of the story may be over by the time we begin to "educate" the child, even if we start at as early an age as three, let alone age six. Secondly, his work is monumental largely because it is tied to and documented by gilt-edged observational data. His theorizing by itself is a virtuoso performance, but the fact that it is rooted in and repeatedly tested against reality makes it unparalleled in child development research in my opinion. For contrast, look at the ratio between theory and empirical material in studies of language acquisition. Roger Brown and Ursala Belugi's ideas are based on comparatively brief observations on an n of 3. What other extensive data exist on the acquisition of language other than vocabulary or phoneme counts? Chomsky, Halle, and Fodor build theories with n's of zero. But we needn't restrict this discussion to topics such as intelligence and language. Aside from Piaget's sensorimotor theory, not a single major theory in child development in this century has been based on observations of human infants and young children. Psychoanalysis was based on data on middle-class female neurotics· learning theory on dogs, mice, and monkeys· Gestalt theory on human adults and mice: and instinct theory on birds and insects. The closest we've come is Gesell's concept of "reciprocal interviewing." and I can't figure out what to do with it.

The research I am going to describe today deals with human infants one to six months of age. You might ask, "Of what relevance is such work to problems of education?" I think there are two reasons why this

work is relevant to this conference. First of all, I feel very strongly that educators must concern themselves with the entire postnatal course of development of adaptive skills rather than events from six or even three years on. Second, I believe that research in child development must be radically re-oriented towards observation and inductive hypotheses, and in describing my work I hope I can provide one example of such an approach.

The research I've been involved in the last eight years concerns the behavior of normal human infants from birth through the first half year of life. I has proceeded along three lines. First, we have attempted to trace the development of the major sensorimotor abilities that infants utilize in their first explorations of the postnatal world. These have included visually-directed reaching, visual exploration, visual accommodation, and the blink response. We have simultaneously tried to identify environmental or experiential conditions which seem relevant to the abilities in question. Lastly, we have carried out a series of enrichment studies in order to determine whether or not early development was significantly dependent upon rearing condition. Our results have convinced us that norms of visual motor development are meaningless without adequate specifications of the rearing conditions. Many of the visual-motor processes we have studied have proven remarkably plastic. We have been able to systematically accelerate and retard the rate of development of behaviors such as visual exploration and visually-directed reaching. Moreover, these changes have been of striking magnitude.

Subjects

Reports based on studies of institutionally-reared infants generally include a statement acknowledging the atypicality of the subjects. It is undoubtedly true that such infants are reared under atypical conditions and in addition they may congenitally constitute a non-representative sample. On the other hand, two factors make such infants unusually suitable for experimental research. First, rearing conditions are virtually identical for each infant in marked contrast to the highly variable conditions for subjects reared in their own homes. Second, it is possible to institute systematic changes in rearing conditions in the institutional setting and to maintain continuous surveillance over their administration.

Figures 1 and 1a illustrate the typical nursery ward facility for infants between the ages of one and four months. As you can see, the world of these infants is essentially bland and uniform.

General Plan

Because of the lack of knowledge about perceptual development in human infants we were faced with the problem of assessing changes in processes about which no normative data existed. Our first task was therefore to assemble such information as fast as the methodological obstacles could be overcome.

After three years of intensive observation we are able to describe in detail the development of visually-directed reaching, visual attention, visual accommodation, and related behaviors such as the discovery of the hands. We have preliminary information on the development of blinking to an approaching visible object and also on visual convergence.

We can also report the results of three attempts to modify the rate of acquisition of visual-motor behaviors by controlled modifications in rearing conditions.

New Normative Data

A. Visually-directed reaching

To the best of our knowledge, no one, aside from Piaget, has studied in detail the acquisition of visually-directed reaching. However, because Piaget was not centrally concerned with prehension, and also since he used only three subjects, his data though very provocative is primarily of suggestive value.

In a recent report we have described a ten step process which culminates in visually-directed reaching of our institutionally-reared infants just prior to five months of age (1). These behaviors and their rate of occurrence may be seen in Figures 2 and 2a.

I should like to draw your attention to the relationship of several of the responses to the ongoing development of these infants. Swiping is a remarkably accurate coordination for a two month old infant. The hand is usually fisted thereby precluding genuine prehension of the object. The swiping movement sometimes appears to be ballistic and at other times the fist is raised and then swung at the object repeatedly. Of basic importance is the fact that in our group, swiping as a test response always occurred at the same age as the discovery of the hands.

Hands to the midline and clasp is characteristic of the bilateral behavior seen during the fourth month of life as the influence of the tonic neck reflex drops out. Torso-orienting reflects the child's growing capacities for gross motor action. What we have called a "Piaget-type" reach was described by Piaget as a raising of one hand to the vicinity of the object, followed by alternation of glance between hand and object, a narrowing of the gap between them, and then contact. This response and the "top level reach reflect a return to unilateral function in the fifth month of life.

We were particularly interested in the fact that swiping at objects appeared as early as the beginning of the third month, but top level reaching did not appear until almost three months later. Was this delay inevitable? Another point of interest was the question of the onset of sustained hand regard. Did this behavior presuppose a certain minimum level of acuity? What role did convergence of the eyes play here?

B. The development of visual attention

In order to determine the sheer amount of visual exploratory activities exhibited by infants, and also to gain a thorough knowledge of their spontaneous visual-motor behavior, we initiated weekly three hour observation periods for each of our subjects.

Briefly, visual attention is defined as the state when the infant's eyes are more than half open, their direction of gaze shifting within 30 seconds.

Figure 3 illustrates the development of this activity from birth through 4-1/2 months of age. It is interesting to note the correspondence between rather dramatic changes in the visible environment and the shape of this curve. For example, the sharp increase in slope at about two months of age is coincident with the discovery of the hands. For the next six weeks or so, the child spends much of his waking time observing his fist and finger movements. The next major change in the visible environment occurred for this group between 3-1/2 and four months. They were transferred to large open-sided cribs. In combination with their greater trunk motility, enabling them to turn from side to side, this relocation suddenly produced a novel visual surround. Coincidentally, the shape of the curve reversed direction and increased markedly.

One goal of the experimental studies which I shall report was to test the notion that the growth of visual attentiveness is markedly influenced by environmental factors.

C. The development of visual accommodation

No systematic studies have been done of the development of visual accommodation in human infants.

Haynes describes dynamic retinoscopy (2) as a test procedure designed to measure the subject's accommodative ability under conditions more relevant to normal function than those used in traditional opthalmological examinations. The subject is tested in a non-drugged state for accommodative response to a target placed at several distances. He is further tested for his capacity to track the target as it is moved toward and away from his eyes. Dr. Haynes performed 111 dynamic retinoscopy examinations on twenty-five of our infants.

With the use of lenses, objective measure of accommodative performance were obtained at target distances varying from four to sixty inches. The infant's capacity to track the target was tested. Further retinoscopic observations were made while the infant spontaneously fixated his hands, the lights in the room, the bars of his crib, or the face of the examiner.

The instrument used was a standard Copeland streak retinoscope with a white cardboard shield mounted so as to prevent the infant from seeing the examiner's head.

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Perfect adjustment to changing target distance would be represented by a slope of 0.00, whereas the complete absence of accommodative change would be indicated by a value of +1.00. Prior to one month of age, the infant's accommodative response does not adjust to changes in target distance. The system appears to be locked at one focal distance whose median value for the group is 7-1/2 inches. This is indicated by a slope value for the group of +1.00. Occasionally, infants of this age did not remain alert long enough to allow complete calibration of their responses. In these few instances, the magnitude of error was estimated (see Fig. 4). Flexibility of response begins at about the middle of the second month and performance comparable to that of the normal adult is attained by the fourth month, as shown by a median slope value of 0.03.

Eleven infants were retinoscoped while asleep in the nursery. In all eleven cases, the accommodative system was totally relaxed.

The major conclusions were that the accommodative system begins to develop flexibility bwtween the third and sixth week after birth. Mature accommodative function is established by 3-1/2 months. By the time swinging behavior occurs, (at about two months) the infant is prepared to focus his eyes close to the target. Convergence as checked by clinical procedures was also found to be sufficiently effective at this time. The range of effective accommodative function increases rapidly during the period when hand regard makes its appearance. Without exception, infants in a rigid TNR posture showed accommodative responses between five and ten inches.

Infants less than one week of age, occasionally exhibited slow changes in accommodative posture, but these were in no way related to position of the target. Older infants, when drowsy, exhibited a gradual drift of accommodative posture towards optical infinity suggesting that the shifting seen in the first week of life was a function of level of drowsiness.

D. <u>The development of the blink response to an approaching visible target</u>

In Riesen's studies, young chimps deprived of experience with patterned light failed to develop the blink responses to approaching visible targets (3). Likewise, in Held & Hein's study of kittens deprived of self-induced motion in the presence of patterned light (4), similar deficits developed with respect to this response among others. No such studies have been done with human infants. Even normative data on the development of this function is unavailable. The literature contains several references to the palpebral response, but in each case the test circumstances combined the visual stimulus with touch or changes in air pressure as the target approached on the face.

We have performed a pilot study on ten infants ranging in age from one month to five months of age. The apparatus we used consisted of a six inch bull's-eye target with 1/4" red and white concentric rings. The object was mounted in a frame directly over the head of the supine infant. A plexiglass shield was placed two inches above the infant to preclude changes in air pressure as the target was dropped toward the subject. The

range of target drop was from 2-5/8 to 12-1/2 inches. Brightness changes are not totally prevented but the sources of light were arranged to minimize such effects. Recording procedures were also crude in this preliminary effort. One observer dropped the target and reported the magnitude and latency of response, the other recorded the data. The results were remarkably consistent.

The median age for the onset of blinking was two months. The maximum target drop was necessary to elicit the response and the responses were often slow and incomplete. By 3-1/2 months, the group exhibited very rapid, completed blinks and even occasional startles in at least seven out of ten trials. A target drop of but 2-5/8 inches was sufficient to elicit these responses.

We have described baseline data for the development of four visual-motor functions, A. visually-directed reaching, B. visual attention, C. visual accommodation, D. blinking to an approaching visible object. Our general research question is "Are these developmental processes plastic? Is systematic contact with the environment instrumental in their development or does the infant simply grow into these skills?"

Experimental Results

A. First modification of rearing conditions

Many recent studies have reported the remarkable effects of postnatal handling on the subsequent development of laboratory-reared lower animals (5,6,7). Mice, kittens, and dogs given small amounts of extra early handling grew up to be "better" animals as measured by a wide variety of tests. They were superior in many physical and adaptive respects. Recent surveys of maternal deprivation studies by Yarrow (8) and Casler (9) suggest that early handling appears necessary for adequate human development. Sylvia Brody in her book "Patterns of Mothering" (10) noted that infants who received moderate handling were consistently more visually attentive than those receiving minimal handling. Would extra handling of our subjects who normally receive minimal amounts, result in accelerated visual-motor development?

From day six through day thirty-six, nurses administered twenty minutes of extra handling each day to each infant (N = 10). Measures of overall development, physical growth, general health, the development of reaching and visual attention were taken regularly between day thirty-seven and one hundred and fifty-two.

There were no changes found in any developmental process except the growth of visual attention. The handled group was significantly more visually attentive than controls (Figure 5). Note that the general shape of the curves are quite similar. Sustained hand regard appeared about one week later in the handled group (1 - 28) than in controls (1 - 20). Upon relocation to large open-sided cribs the handled group, like controls, exhibited a sharp increase in visual attentiveness.

Aside from the relationship between handling and visual attentiveness, the major finding of this study was that an environmental modification resulted in a significant alteration in the rate of growth of visual exploratory behavior. No evidence for comparable plasticity in other visual-motor developments was found in this study. It is possible that further exploration of the effects of early handling would produce still greater shifts in visual exploratory behavior. Because this problem was not central for us, and because the cost in terms of time and money is so great in research with human infants, we did not pursue this task.

Instead, we turned our attention back to the role of motility and visual stimulation in visual-motor development. I will refer to two subsequent studies in which the experimental regimen consisted of extra handling followed by heightened motor activity in enriched surrounds.

B. Second modification of rearing conditions

Several recent studies seem to indicate that these visual-motor capacities depend to a significant extent on experience of some kind for their subsequent development. Riesen's early work demonstrated that chimpanzees required exposure to patterned visible stimulation for normal visual-motor development (3). His later studies have shown that movement within such environments was also required for adequate development (3). Held and his collaborators (11, 12) have repeatedly shown that human adults require the opportunity for self-induced motion in dependably structured environments for adaptation to rearranged sensory inputs. More recently they performed a study with kittens which demonstrated the applicability of these findings to developmental processes (5). The results of this study indicated that movement per se in the presence of a dependable surround was insufficient for normal visual-motor development. Kittens whose movements were externally-produced rather than self-induced did not develop normally. Self-induced movement in a dependable surround was found necessary for adequate development as well as maintenance of visual-motor behavior.

Our subjects are normally reared under conditions which are obviously less than optimal with respect to such experience. Motility is inhibited by soft mattresses with depressions in them and constant supine posture. The visual surround is poorly figured. Heightened motility in an enriched surround should therefore produce accelerated visual-motor development.

As a first test we enriched the condition of environmental contact of a group of nineteen infants in as many respects as possible.

a. Increased tactual-vestibular stimulation - Each infant received twenty minutes of extra handling each day from day six through day thirty-six.

b. Increased motility - Infants were placed in the prone posture for fifteen minutes after the 6 a.m., 10 a.m., and 2 p.m. feeding each day from

day thirty-seven through day one hundred and twenty-four. At these times, the crib liners were removed, making the ward activities visible to the child. Movements of the head and trunk in the presence of a figured visual surround resulted from the normal tendency of infants to rear their head under such circumstances. The crib mattresses were flattened, thereby facilitating head, arm, and trunk motility.

c. Enriched visual surround - A special stabile featuring highly contrasting colors and numerous forms against a dull white background was suspended over these infants from day thirty-seven through day one hundred and twenty-four. In addition, printed multi-colored sheets and bumpers were substituted for the standard flat white ones (Figure 6 and 6a). These changes were designed to produce heightened visual interest and increase viewing of hand movements because of the normal tendency of infants to swipe at visible objects nearby.

Weekly measures of prehensory responses and visual attention were made. The rate of development of spontaneous behavior relevant to visual-motor function such as hand regard, hands touching at the midline, mutual fingering and torso turning was assessed from the records of the three hour observations. Performance on the Gesell tests was recorded at bi-weekly intervals to determine general developmental progress. Also, records of rate of weight gain and general health were kept.

Results

1. Hand regard and swiping

Hand regard as such was much less frequently shown by this group as compared with controls. Instead the hands were generally first observed as they contacted portions of the experimental stabile. We called this pattern monitored stabile play and considered it together with monitored bumper play as forms of hand regard. By these criteria, the onset of hand regard was delayed for some two weeks in our experimental group. The onset of swiping was also set back, but only by some five days.

Figure 7 illustrates the responses to the test object leading to reaching for this group.

2. Prehension

The median age for the first appearance of top level reaching was three months and seven days for the experimental group, an advance of some 6-1/2 weeks. Some of the types of preliminary responses reported for our control group did not occur prior to the onset of top-level reaching.

3. Visual attention

The course of development of visual attention was also altered dramatically in our experimental group as illustrated by Figure 8. Concurrent with the unexpected delay in the onset of hand regard, was a marked decrease

in visual exploratory behavior for the first portion of the test periods. On the other hand, once the group began to engage in prehensory contacts with the stabile and figured bumpers visual attention increased sharply.

Clearly the results of this study demonstrated the plasticity of several visual-motor developments. That the onset of hand regard in part is a function of environmental factors is not a novel notion. Hand regard is a 12 week behavior on the Gesell scale, whereas our control infants, with virtually nothing else to view discovered their hands at less than 2 months of age. Piaget noted that the onset of this behavior varied by as much as three months among his own children as a function of differing environmental circumstances (13). Therefore, the fact that infants provided with enriched surrounds were late in discovering their hands compared to controls was not totally unexpected.

We were surprised that the group exhibited less visual attention during the first five weeks in the enriched visible surround. In fact, not only did they tend to ignore the stabile and bumpers, but it is my impression that they engaged in much more crying than the control group during the same period. Starting at about 2 months and 12 days of age the group as a whole began to engage in a great deal of stabile play. As we had suspected, the rattles were repeatedly swiped at thereby producing far more monitored hand and arm movements than would normally have occurred. Subsequently, in less than one month, the integration of the grasp with approach movements had been completed. You will remember that control infants required almost 3 months for this transition.

Earlier we had noted that the course of development of visual exploratory behavior seemed to reflect the availability of interesting things to look at. We had seen that in control and handled groups the slope of the curve of visual attention increased sharply when the hands were discovered and then decreased during the next six weeks. In this experimental group it appears that for about a month starting at 1 month and 7 days, the enrichment was actually ineffective and perhaps even unpleasant. However, once positive responses to the surround began to occur visual attention increased sharply in striking contrast to the previous groups. The dip seen at 3 1/2 months in both previous groups disappeared.

C. Further modification of the environment. Until day 37 the procedures were the same as in Study B, but instead of enrichment by prone placement and the stabile and printed sheets and bumpers, there was only one modification from day 37 until day 68. Two pacifiers were mounted on the crib rails. These devices were made to stand out visually by appending to them a red and white pattern against a flat white background (Figure 9). The objects were 6 to 7 inches away from the corneal surfaces of the infants' eyes. They were positioned so as to elicit maximum attention from a 6 to 10 week old infant. The normal tendency of such infants is to accommodate at about 8 to 10 inches. It was assumed that the pacifiers might have the effect of orienting the infant towards the discovery of his own hands. It was further assumed that these objects might provide appropriate anchor points in space intermediate between the locus of spontaneous fixation and the ordinary path of motion of the hand extended in the tonic neck reflex posture.

At 68 days the infant was then placed in a crib with a stabile similar to that used in the previous study until he was 124 days of age. We hypothesized that these infants would be more consistently precocious in the attainment of visually-directed reaching. We also expected consistantly higher visual attention from this group.

Results

1. Hand regard and swiping. In the control group the onset of sustained hand regard occurred at day 46. Infants in the handling study were slightly behind (day 60). Infants in study B were even later in this respect (day 66) supporting the idea that the discovery of the hands is, in part, a function of the availability of interesting visible objects (1). The modified enrichment of this last study seemed more appropriate for the infant during the second month of life. Study C infants exhibited sustained hand regard at day 45. It should be noted that control infants reared in bland surroundings are about as advanced in this regard. The onset of swiping responses followed the same general pattern with study C infants exhibiting this behavior earlier than all other groups (day 58; Figure 10).

2. Prehension. Apparently, the modified or paced enrichment of the last study was the most successful match of external circumstances to internally developing structures as indicated by the acquisition of top level reaching at less than 3 months (day 89 - significantly earlier than controls at $p < .001$-Mann-Whitney U Test).

3. Visual Attention. Figure 11 shows visual attention data for the subjects of the several studies. The depression of visual interest shown by study B infants from (day 37) to (day 74) has been eliminated. Curiously, although the last group was more consistently attentive than the others, the reduction of such behavior at 3 1/2 months appeared as it had in the first two groups. It would appear that some uncontrolled variable is interacting with our various attempts at modifying the function.

Conclusions

1. The significance of the age range from 1 1/2 - 5 months of age. The first major conclusion derivable from our research is that the age range from 1 1/2 to 5 months is a time of enormous importance for early perceptual-motor development. According to our findings and those of others, human infants reared under natural conditions show a dramatic surge in both visual activity and development at the middle of the second month of life. During the next 3 1/2 months the following events occur: (1) the development of flexible accommodative function culminating in virtually adult-like performance at 3 1/2 months, (2) discovery of the hands and gradual development of manual control by the visual system culminating in true visually-directed reaching, (3) the initiation and complete development of the blink response to an approaching visible target, (4) the initiation and complete development

of the blink response to an approaching visible target, (4) the initiation and complete development of visual convergence, (5) the onset of social smiling.

2. Plasticity in human visual-motor development. The studies reported above demonstrate that aspects of early visual-motor development are remarkably plastic. As yet we know neither the limits of this plasticity nor the range of visual-motor functions that fall within this classification. At the very least, the onset of hand regard and visually-directed reaching and the growth of visual attentiveness are significantly affected by environmental modification. Infants of both group B and C developed top level reaching in approximately 60% of the time required by the control group, a result very much in line with the theory that self-initiated movement with its visual consequences is crucial for visual-motor development. Whether or not visual accommodation, convergence, pursuit, and blinking to an approaching target share this plasticity remains to be seen. Assessment of the extent to which various types of mobility and specific environmental factors contribute to these and other perceptual motor developments is the goal of our continuing research.

I think we've shown clearly that enrichment procedures can produce remarkable effects on the course of early development. Now, you may rightly point out, as Eleanor Maccoby has in the past, that we've known for years that short-term effects on development are possible at various stages of growth. And one can ask, "are there any long-term consequences of such experiences?". My answer would be that the question has usually been posed incorrectly. In education, one doesn't expect to provide instruction to a six year old for six months and then find profound consequences at age 18. We assume that education is a continuing, long-term process. We therefore attempt to design the interventions of each succeeding year so that they mesh with prior events. Further, we recognize the cumulative nature of the process. A deficit in elementary language or reading skills plagues the student at every succeeding grade level.

We will never know very much about the maximal effects of experience on development until we can perform similar cumulative matching studies throughout the developmental years starting from birth. I don't pretend that this is a modest problem. It will take time, and most of all, at least a hundred times the knowledge we now have about child behavior.

In conclusion, I believe that any scientific endeavor must start with observations. The more complex the subject, the more extensive the observations required. Since humans and their adaptive abilities are frightfully complex, we need enormous amounts of first-quality observations. The second phase of such a program is where theory comes in. The major function of a theory is to bring order into an array of events. I am making a plea for inductive theorizing. I maintain that child development and early childhood education is woefully barren with respect to observational data and until we recognize and remedy this deficiency we will continue to build castles of sand.

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